Ontario Geological Survey

Report 184

Geology of the

Twopeak Lake Area

District of Cochrane

By

B.C. Wilson

Compliments of
ONTARIO
MINISTRY OF NORTHERN DEVELOPME 1
AND MINES
Not for resale

1979

Ontario

Ministry of Natural Resources

Hon. James A.C. Auld
Minister

Dr. J.K. Reynolds
Deputy Minister

93-01341/

© OMNR-OGS 1979
Printed in Canada

Publications of the Ontario Ministry of Natural Resources,
and price list are obtainable through the
Map Unit, Public Service Centre, Queen's Park, Toronto
and the
Ontario Government Bookstore
880 Bay Street, Toronto.
Orders for publications should be accompanied by cheque
or money order, payable to the *Treasurer of Ontario*

Parts of this publication may be quoted if credit is given. It is recommended that reference to this report be made in the following form:

Wilson, B.C.
1979: Geology of the Twopeak Lake Area, District of Cochrane; Ontario Geological Survey Report 184, 38p. Accompanied by Map 2410, scale 1:31 680 (1 inch to ½ mile).

1000-300-78-U of T

CONTENTS

PAGE

Abstract v
Introduction 1
Location and Accessibility 1
Physiography 1
Previous Work 2
Field Work 2
Acknowledgments 3

General Geology 3
Table of Lithologic Units 6
Precambrian 7
Early Precambrian 7
Metavolcanics and Metasediments 7
Mafic Metavolcanics 7
Massive and Pillowed Flows 7
Feldspar Porphyry Flows 10
Tuff, Lapilli-Tuff, and Lapillistone 11
Metasediments 14
Micaceous Sandstone, Schist, Iron Formation 14
Conglomerate, Sandstone, Mudstone, and Iron Formation 15
Ultramafic Intrusive Rocks 18
Peridotite 18
Felsic Intrusive Rocks 20
Granodiorite and Porphyritic Granodiorite 20
Early to Late Precambrian 20
Mafic Intrusive Rocks 20
Diabase 20
Phanerozoic 21
Cenozoic 21
Quaternary 21
Pleistocene and Recent 21

Summary of Magnetic Data 21

Structural Geology 22
Folding 22
Foliation and Lineation 24

Geological History and Regional Synthesis 24
Economic Geology 25
Description of Properties and Occurrences 26
Cannon Mines Limited [1967] (1) 26
Conwest Exploration Company Limited [1960] (2) 26
Dome Exploration (Canada) Limited (3) 27
Eagle Head Mines Limited [1967] (4) 28
Force Crag Mines Limited [1968] (5) 28
Geophysical Engineering Limited (6) 28
Hudson Bay Exploration and Development Company Limited (7) 28
Movado Mining Company Limited [1968] (8) 29
Noranda Exploration Limited [1968] (9 and 10) 29
Raejac Exploration Limited [1968] (11) 31
Summit Explorations and Holdings Limited [1967] (12) 32
Texas Gulf Sulphur Company Incorporated [1967] (13) 32
Tripoint Mines Limited [1967] (14) 34

Suggestions for Exploration 34

References 35

Index 37

TABLES

PAGE

1–Table of Lithologic Units 6

2–Chemical analyses and molecular norms of metavolcanics 12

3–Chemical analyses and molecular norms of metasediments 16

4–Chemical analyses and molecular norms of ultramafic intrusive rocks 19

FIGURES

1–Key map showing location of Twopeak Lake map-area v

2a–Jensen Cation Plot 4

2b–AFM Plot 5

3a–Generalized shape of a pillow 8

3b–Initiation of growth of pillow 8

3c–Continued growth of pillow 8

4–Structure of the supracrustal rocks 23

5–Aeromagnetic map of most of the Burntbush River Sheet ..... (Chart A, back pocket)

PHOTOGRAPHS

1–Boudinaging of layering in massive flows 10

2–Photomicrograph of intergrowth of garnet and grunerite 14

GEOLOGICAL MAP

(back pocket)

Map 2410 (coloured)–Twopeak Lake Area, District of Cochrane.
Scale 1:31 680 (1 inch to ½ mile).

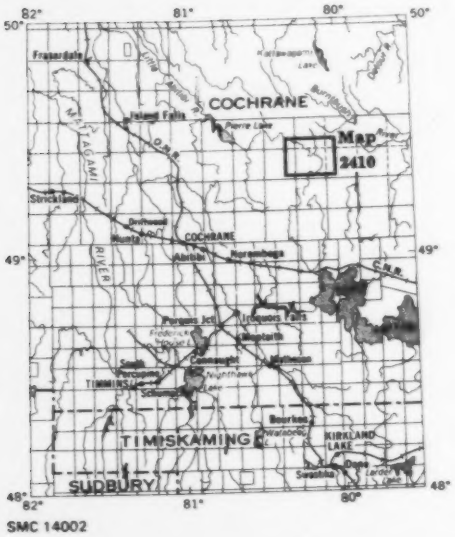
CHART

(back pocket)

Chart A–Figure 5.

ABSTRACT

The Twopeak Lake Area, comprising an area of about 500 km² is located 130 km northeast of Timmins. Early Precambrian rocks include a supracrustal succession of, from the base upward: metasediments; massive and pillowed mafic flows with minor feldspar porphyry flows and thin interbedded metasediments; mafic pyroclastic rocks; and micaceous metasediments. These are cut by ultramafic, mafic, and felsic intrusive rocks. The felsic intrusive rocks may be remobilized rocks derived from a pre-existing granitic basement. The supracrustal rocks, probably folded during gravity-driven subsidence, have been altered under conditions of low-grade metamorphism. Post-tectonic, Early to Late Precambrian diabase dikes cut the granitic and supracrustal rocks. Pillow shapes in mafic flows suggest a centre of volcanism to the east or northeast of the map-area.


82°
81°
80°
50°
49°
48°
COCHRANE
Map
2410
TIMISKAMING
SUDBURY
KIRKLAND LAKE
TIMMINS
Fraserdale
Island Falls
Pierre Lake
Smooth Rock Falls
Kapuskasing
Matheson
Swastika
Larder Lake
Dane
Bourkes
Virginiatown
Englehart
Ferguson Jct
Iroquois Falls
Abitibi
Moonbeam
Normetaqua
Driftwood
Munro
Arctic
Strickland
Frederick House
Lake
Lake
Lake

Geology of the
Twopeak Lake Area
District of Cochrane

by

B. C. Wilson[1]

INTRODUCTION

Location and Accessibility

The Twopeak Lake map-area, bounded by Longitudes 80°W and 80°22′30″W and by Latitudes 49°20′N and 49°30′N, lies about 130 km northeast of Timmins, Ontario. The area examined comprises 500 km^2 and includes parts of Tweed, Blakelock, Hoblitzell, Bragg, Newman, and Tomlinson Townships. Because no roads extend into this area, access into it must be provided by boat, helicopter, or float-equipped aircraft. Most of the lakes are sufficiently large and deep to enable float-equipped aircraft to land on them. The Mikwam River is navigable by canoe until late summer. The navigable part of this river begins at an outcrop 5 km south of Snare Lake, and extends beyond the map-area to the north. The Floodwood River between Twopeak Lake and Floodwood Lake, by way of Wasicho Lake, is navigable with difficulty. A light canoe should be used on this river in late summer because of the low water levels.

Fixed-wing service is available in South Porcupine (near Timmins), in Cochrane 70 km southwest of Twopeak Lake, and in Kapuskasing 160 km west of Twopeak Lake.

Physiography

Twopeak Lake gets its name from two bedrock outcrops that are 106.0 m above the level of the lake 1 km west of its southern end. These hills give a total

[1]Geologist, Ontario Geological Survey. Manuscript accepted by the Chief Geologist, and Chief, Precambrian Geology Section, 31 March, 1977.
This report is published with the permission of E.G. Pye, Director, Ontario Geological Survey.

relief for the map-area of 122.8 m, though local relief rarely exceeds 10.0 m. A thick mantle of glacial clay, silt, sand, and gravel covers the map-area. Most of the ground is dry, consisting of low, drumlinoid features densely populated by poplar and small peat flats sparsely covered by spruce. Swampy areas contain dense tag alder, and are adjacent to most small streams. Exposures of bedrock are rare; the bulk of the rock is exposed just west of Twopeak Lake

The area is drained northward by the Little Abitibi, South Floodwood, Floodwood, and Mikwam Rivers, all of which originate near the southern boundary of the map-area.

Previous Work

The Burntbush River Area,including much of the Twopeak Lake map-area, was first mapped by Thomson (1936) for the Ontario Department of Mines. Thomson's report includes a map at a scale of 1:126 720 (1 inch to 2 miles) which is generally in agreement with the author's map. A much larger area was mapped by Bennett *et.al* (1966) as part of Operation Kapuskasing (Bennett *et al.* 1967) also at a scale of 1:126 720 (1 inch to 2 miles). Their mapping differs from the author's map, (Map 2410, back pocket) most importantly in that outcrops of felsic to intermediate metavolcanics have been remapped as mafic metavolcanics. Work submitted by private companies for assessment credit, on file in the Resident Geologist's Office, Ontario Ministry of Natural Resources, Kirkland Lake Ontario, includes aeromagnetic, ground magnetic, and electromagnetic surveys, geological mapping, and diamond drilling. Diamond-drill logs submitted by Texas Gulf Sulphur Company in 1967 record considerable lengths of felsic to intermediate metavolcanics intersected by drilling. It is probable that many of these rocks are more mafic than was thought at that time (V.N.Kelly, Geologist, Texasgulf Incorporated, Toronto, Ontario, personal communication 1976).

Field Work

Geological mapping was carried out during the 1976 field season at a scale of 1:15 840 (1 inch to ¼ mile) for reproduction at a scale of 1:31 680 (1 inch to ½ mile), see Map 2410, back pocket. Vertical aerial photographs at an approximate scale of 1:15 840 (1 inch to ¼ mile), were supplied by the Division of Forests, and were used for field mapping procedures. The base-map was prepared by the Cartography Section, Division of Lands, from map-sheets of the Forest Resources Inventory of the Division of Forests. Traverses by pace and compass were made at irregular intervals to visit outcrops known to exist from previous mapping and from the examination of aerial photographs. Few exposures were missed because most of the outcrops are apparent from an examination of the aerial photographs. The large area of outcrops just west of Twopeak Lake (see Map 2410, back pocket) was examined in great detail from a base-camp located on the edge of Twopeak Lake. A trail leads from this campsite, an old forestry station, to an abandoned fire tower located on these outcrops.

Acknowledgments

The author was ably assisted in the field by J. Arengi,senior assistant, and by R. Jonasson, J. Peacock, and H.A. Wasteneys, junior assistants. Thanks are extended to them for their work, and to W.O.Karvinen, Resident Geologist at Timmins, and H.L. Lovell, Resident Geologist at Kirkland Lake for their interest and aid in the field project. Special thanks are due Dr. D.R. Pyke, Division of Mines, for his supervision and encouragement during all stages of the mapping project.

GENERAL GEOLOGY

The Pleistocene cover of unconsolidated clay, sand, and gravel is thick and extensive; bedrock outcrops are few. Bedrock within the map-area consists of metavolcanics, metasediments, and ultramafic, mafic, and felsic intrusive rocks of Early Precambrian age which are intruded by Early to Late Precambrian diabase dikes (Table 1). The supracrustal rocks have been altered under conditions of low grade metamorphism (Winkler 1976). Mineral assemblages in mafic metavolcanics comprise mainly plagioclase, actinolite, and chlorite. Occasional amphibolite containing plagioclase, hornblende, and chlorite suggest, as does the presence of almandine garnet in some metasediments, that at least locally, the higher temperature part of low-grade metamorphism was reached.

Outcrop in the map-area is limited and diamond-drill data on file in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake, is scant. Using this data and the regional aeromagnetic maps (ODM-GSC 1964a,b,c,d,e, and f) the author has interpreted the stratigraphic section to have at its base a unit of metasediments, covered by a series of mafic flows and pyroclastic rocks, and at the top, a unit of micaceous metasediments. Relatively thin units of metasediments are interlayered with flows throughout the metavolcanic section.

The metavolcanics west of Twopeak Lake are dominantly massive and pillowed mafic flows containing minor feldspar porphyry flows. The massive and porphyritic flows are in part intrusive into older flows. A minor amount of pyroclastic rock was found 3900 m southwest of Twopeak Lake. The metavolcanics to the southeast of Magiskan Lake are mafic massive flows; those to the northwest are dominantly mafic pyroclastic rocks above minor massive and pillowed flows. Pyroclastic rocks include thick- to thin-bedded tuff, lapilli-tuff, and lapillistone, and occasionally a small amount of possibly felsic to intermediate metavolcanics. Chemical analyses show that the metavolcanics are calcalkaline and tholeiitic basalt and andesite. The biotite-rich metasediments at the top of the stratigraphic section are composed of micaceous sandstone, and schist, with some iron formation. The metasediments interbedded with, or lying below the mafic metavolcanics are chloritic and comprise conglomerate, sandstone, mudstone, and minor amounts of iron formation. All the metasediments show rhythmic patterns of thick-bedded coarse-grained sedimentary rocks and alternating thin-bedded coarse- and fine-grained sedimentary rocks which suggest that turbidite sedi-

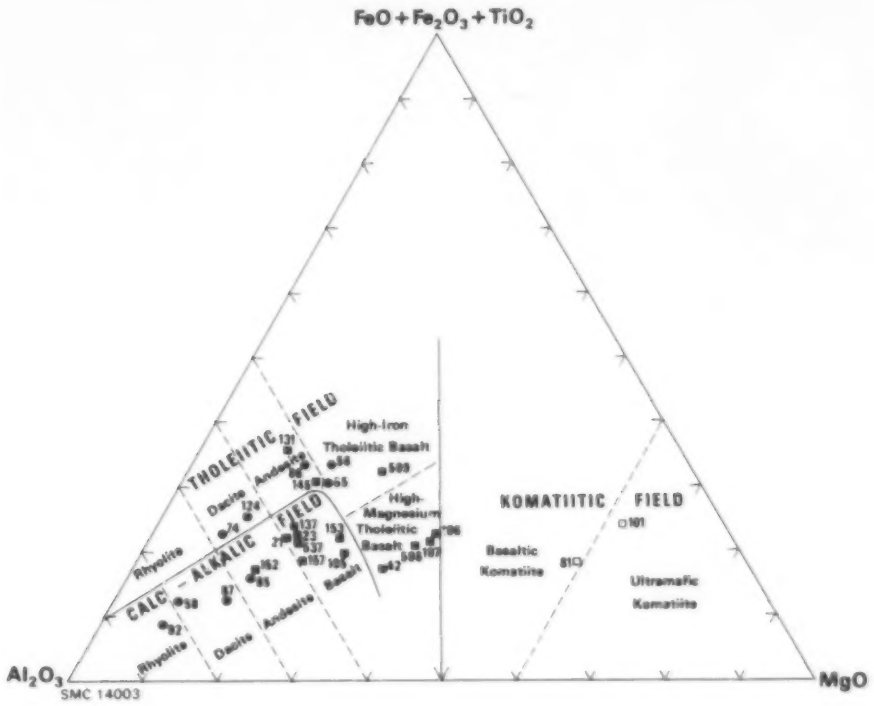


Figure 2a–Jensen Cation Plot of Metavolcanics in Twopeak Lake Area. Squares are Metavolcanics. Circles are Metasediments. Open squares are Ultramafic Rocks. See Tables 2, 3, and 4 for sample locations.

mentation, typical of Early Precambrian (Archean) greenstone belts, occurred. Chemical and clastic sedimentary rocks are present; these two types of rock are commonly intermixed.

Metasediments which outcrop along the South Floodwood River and thin metasedimentary layers interbedded with the metavolcanics are dominantly chemical in origin. These rocks are probably related to iron formation reported in diamond-drill holes in the area (see Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake). Other outcrops of metasediments, including the thicker layers interbedded with the metavolcanics, are dominantly clastic. Clastic sediments include lithic fragments of tuff and crystal tuff and crystal fragments of plagioclase probably derived from crystal tuff. The author proposes that the clastic material was derived from consolidated and unconsolidated pyroclastic, hyaloclastic, and erosional volcanic and sedimentary material. Chemical analyses, the results of which are shown in Figure 2a and b, indicate that the chloritic metasediments occur in the calcalkaline rhyolite, dacite, and

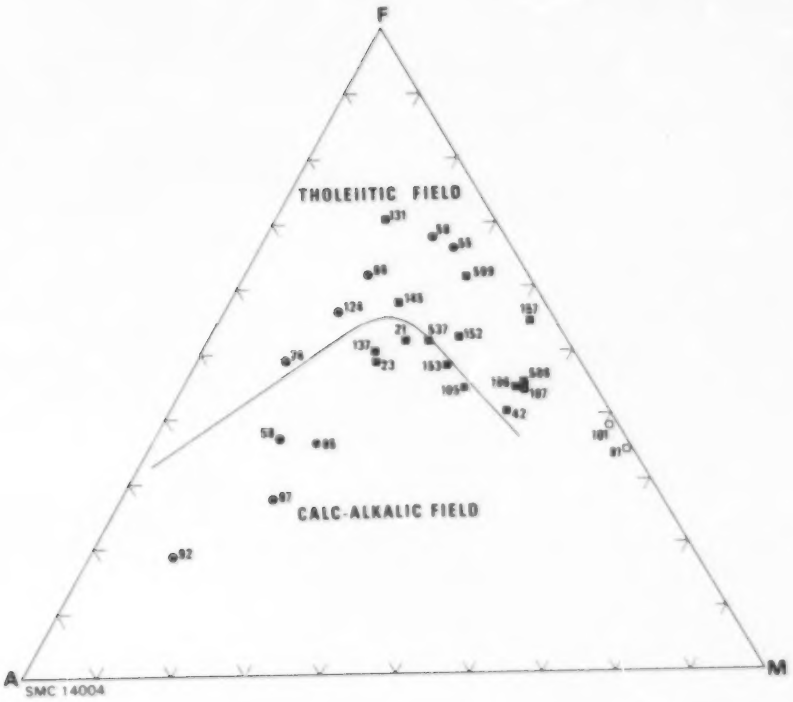


Figure 2b–AFM Plot of Metavolcanics in Twopeak Lake Area. Squares are Metavolcanics. Circles are Metasediments. Open squares are ultramafic rocks.

andesite, and tholeiitic dacite, andesite, and basalt fields in the Jensen Cation Plot (Jensen 1976).

A few ultramafic intrusive rocks cut the massive and pilliowed mafic flows. In one siil examined by the author, the contact relationship with the surrounding mafic flows is unclear; the sill could be interpreted as a flow. Chemical analyses of these intrusive rocks (Figure 2a) reveal that they are komatiitic peridotites and basalts similar in composition to spinifex-bearing ultramafic flows in Munroe Township Ontario (D.R.Pyke, Geologist, Division of Mines, Toronto, personal communication, 1976).

Massive to weakly foliated granitic rocks outcrop throughout the map-area. These rocks comprise granodiorite, and near Twopeak Lake, porphyritic granodiorite which intrudes the metavolcanics. The supracrustal rocks generally dip and face away from the granitic masses. This suggests that these granitic rocks may represent a base upon which the supacrustal rocks were deposited. Massive, north-trending diabase dikes are commonly coarse grained and porphyritic. The resistance to weathering of these dikes probably accounts for the continued ex-

TABLE 1 TABLE OF LITHOLOGIC UNITS FOR THE TWOPEAK LAKE AREA

PHANEROZOIC
CENOZOIC
QUATERNARY
PLEISTOCENE AND RECENT
Clay-till, varved clay, silt, boulder clay, sand, gravel, organic mud, and peat
Unconformity
PRECAMBRIAN
EARLY TO LATE PRECAMBRIAN
MAFIC INTRUSIVE ROCKS
Diabase
Intrusive Contact
EARLY PRECAMBRIAN
FELSIC INTRUSIVE ROCKS
Granodiorite, porphyritic granodiorite
ULTRAMAFIC INTRUSIVE ROCKS
Peridotite
METAVOLCANICS AND METASEDIMENTS
METASEDIMENTS
Micaceous sandstone, schist, conglomerate, sandstone, mudstone, iron formation
MAFIC METAVOLCANICS
Massive and pillowed flows, feldspar porphyry flows, tuff, lapilli-tuff, lapillistone

posure of most of the bedrock presently visible in the Twopeak Lake area.

The geological contacts shown on the accompanying map, (Map 2410, back pocket), were interpreted from scant data and are thus highly speculative. Much of the interpretation was done from the regional aeromagnetic maps (ODM-GSC 1964a,b,c,d,e, and f) on which mafic flows may be traced by a series of magnetic depressions and the micaceous metasediments by strong magnetic highs that are presumably caused by the presence of abundant magnetite iron formation. The location of the contact between these units can thus be approximated. This contact is probably not simple. Diamond-drill data, and to a certain extent outcrop data indicate that there is considerable interbedding of metasediments and metavolcanics. The contact shown at best represents the region in which the transition from dominantly metavolcanics to dominantly metasediments takes place. Additional complexities caused by isoclinal folding northwest of Magiskan Lake make the tracing of contacts there more uncertain.

The presence of felsic intrusive rocks north of Twopeak Lake has been inferred from diamond-drill and outcrop data. Diamond-drill holes drilled northwest and east of Magiskan Lake intersect felsic intrusive rocks which intrude the metavolcanics and metasediments. A diamond-drill hole which plunges south at 45° just north of the map-area, about 11 km north of Twopeak Lake, intersected 66 m of metavolcanics followed by 37 m of metasediments then 59 m of granite (Resident Geologist's Files, Ontario Mininstry of Natural Resources, Kirkland Lake).

Precambrian

EARLY PRECAMBRIAN

Metavolcanics and Metasediments

MAFIC METAVOLCANICS

Massive and Pillowed Flows

Much of the bedrock exposed in the Twopeak Lake area comprises metamorphosed massive and pillowed mafic flows. Flow morphology from the base upward consists typically of a narrow fine-grained chill margin, a coarse-grained centre which is transitional upward into finer grain sizes, and a pillowed top. Undeformed pillows average about 30 by 45 cm and may comprise from 20 to 90 percent of a flow. The flows range in thickness from 0.3 to 90 m, and although thicker flows may be traceable along strike for 100 m or more, most flows can be followed for only short distances. Pillow shape and packing, and flow morphology provide abundant top directions.

Thin stringers and irregular bodies of gabbroic rock cut the mafic flows and are indistinguishable from coarse-grained flow centres. These rocks probably represent subvolcanic intrusions from the same magma source as the flows. The similarity between the gabbroic rocks and the mafic flows make estimates difficult, but the intrusive rocks probably form less than 1 percent of the total volume of the mafic pile.

Flow boundaries are marked by sharp contacts between pillowed and unpillowed rock, and coarse- and fine-grained rock, or by thin layers of metasedi-

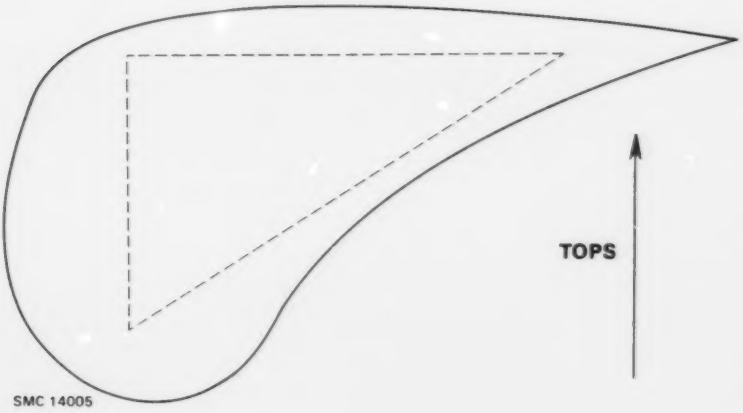


Figure 3a–Generalized shape of a pillow approximating that of a right-angled triangle.

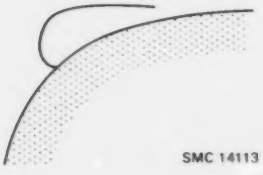


Figure 3b–Initiation of growth of pillow.

Figure 3c–Continued growth of pillow.

ments (see section on "Metasediments"). In an outcrop just west of Twopeak Lake although the bedding trends N20°W, the long axes of pillows trend on the average, N5°E, and the foliation trends N30°E. Bedding directions inferred from pillow or foliation trends therefore, must be used with care.

In this same outcrop most of the flows have a coarse-grained lower part. The thickness of this part decreases southward and, in a few flows, the coarse-grained part disappears completely. The coarse-grained material probably represents rock which was hot and cooled slowly. The author suggests that the thinning of this layer may have taken place in the direction of flow. Magma which flowed farther, as at the southern end of the outcrop, was cooler, and so little or no coarse-grained rock was formed at the bottom of the flow. The conclusion that the flow direction was from north to south is supported by a study of pillow shapes in the same outcrop.

Many of the pillows are roughly the shape of a right-angled triangle with one acute angle pointing stratigraphically downward and the other pointing horizontally (Figure 3a). Pillows usually grow on top of other pillows, as is implied by top determinations made from pillow shape and packing. Pillows such as that shown in Figure 3, therefore, could have been formed by being draped over the edge of another pillow. If these pillows grew from the tail end as is shown in Figures 3b and 3c, the tails point in a direction opposite to the flow direction.

Almost all of the pillows of this shape in the outcrop studied had tails pointing north giving a flow direction from north to south. Flow directions determined in the manner described above were made from a large number of outcrops in the area west of Twopeak Lake, and gave a consistent pattern of flow directions. This pattern indicates that a centre of volcanism is located east or northeast of the map-area. Pillows of this shape are not found throughout the outcrop area west of Twopeak Lake, and occur only in the area close to and northwest of the fire tower. In the northwest-trending parts of the mafic metavolcanics, closer to the South Floodwood River, the pillows generally are oval on horizontal surfaces.

Outcrops are well foliated, usually but not always paralled to bedding directions. Those close to the trace of the axial plane of the syncline are strongly flattened or "sheared". Pillows are often greatly elongated parallel to the dip of the foliation, and are slightly elongated parallel to the strike. The down-dip elongation is parallel to amphibole lineations which pitch 90° on the foliation surface. Boudins in apparently homogeneous layers indicate differences in competence and thus in composition which are not otherwise observable on the outcrop surface (Photo 1). Differences in the degree of foliation show similar differences in composition. Strongly foliated, and usually iron-stained zones range in width from l m to as much as 10 m.

Weathered surfaces are dark green to black where covered by lichens, or light to dark green where freshly exposed. Fresh hand specimens are light to dark green and grey-green; the lighter colours result from higher degrees of epidotization. Grain sizes range from much less than 1 mm to as much as 5 mm, but average from 1 to 2 mm. Unfoliated specimens are granoblastic and homogeneous. Well foliated specimens are often very finely banded, probably the result of segregation during recrystallization of the felsic and mafic components. Subsequent epidotization of plagioclase bands has in some locations accentuated the layering effect. Southwest of Twopeak Lake some of the flows contain pillows with white-weathering cores. Thin sections show that in these cores, the plagioclase has been almost completely epidotized.

Typical mineral assemblages include an acicular, pale green, weakly pleochroic, actinolitic amphibole (or rarely hornblende) and plagioclase, with varying, but generally minor amounts of epidote, chlorite, quartz, carbonate, and opaque minerals. Biotite and apatite were found in very minor amounts. Plagioclase and amphibole comprise 80 to 95 percent of the rock, and occur in about equal proportions. Plagioclase is usually fine grained and altered which prevents an accurate determination of its An content. Quartz and carbonate are common as fillings in vesicles and fractures. Original textures were not observable because of the high degree of recrystallization of felsic and mafic components.

The results of partial whole-rock analyses are shown in the Jensen Cation

OGS 9847

Photo 1–Boudinaged layers in massive flows.

and AFM plots in Figures 2a and 2b. In Figure 2a the flows plot as calcalkaline basalts, high magnesium and high iron tholeiitic basalts, and tholeiitic andesite. The epidotized core of a pillow plots as a calcalkaline andesite while the unaltered part plots as a calcalkaline basalt. Although no definite differentiation trends were determined from this data, these rocks appear to comprise a dominantly tholeiitic suite. The compositions of the mafic flows are shown in Table 2, page 12.

Feldspar Porphyry Flows

A small proportion (less than 1 percent) of the flows are porphyritic, with 5 to 15 percent plagioclase phenocrysts. The phenocrysts range in size from 0.5 to 15 cm and average 0.5 to 2 cm. These flows are partly intrusive into the massive and pillowed mafic flows forming dikes 0.5 to 2 m in thickness or more rarely,

nearly circular intrusions of 1 to 3 m in diameter. Flow thicknesses are difficult to determine but may be as much as 15 m. Apparently no preferred trend of the dikes relative to either the bedding or foliation directions exists.

The rock surfaces are dark green to black where covered by lichens, or light to dark green when freshly exposed. Fresh hand specimens are dark green and show light green altered plagioclase phenocrysts. The phenocrysts often weather recessively and produce a spotted texture on the outcrop surface. The grain size of the matrix is generally less than 1 mm. This matrix is indistinguishable on the outcrop surface or in hand specimens from the matrix observed in the surrounding mafic flows, and is assumed to be composed dominantly of plagioclase and amphibole.

Tuff, Lapilli-Tuff, and Lapillistone

The mafic pyroclastic rocks mainly outcrop north of Twopeak Lake. There, the rocks are moderately foliated and well bedded. Bedding thickness is 1 m thick or greater. Although fine laminations are detectable in some tuffs, primary structures other than bedding are not observable in the field. The rocks northwest of Magiskan Lake are isoclinally folded. Fold amplitudes and wavelengths of less than 0.5 m are visible on the outcrop surface; much larger amplitudes and wavelengths of folds are indicated by changes in the dip of foliation and bedding. Folding makes it impossible to estimate the stratigraphic thicknesses of units in the part of this map-area.

Southwest of Twopeak Lake, a layer of lapillistone, with an estimated thickness of 15 m, was found overlying pillowed flows. This outcrop is very strongly foliated, and lapilli, which average 20 mm by 60 mm, are deformed into "S" curves. The lapilli weather recessively giving a spotted outcrop surface very similar to that of the feldspar porphyry flows.

Rock surfaces are dark green to black where covered by lichen and lighter green to dark green where freshly exposed. Fresh specimens are medium to dark green and grey-green, and occasionally contain lighter green fragments. Grain size in the matrix is usually less than 1 mm with lapilli from 2 mm to 60 mm. Lapilli include both lithic fragments and feldspar crystals, the latter in crystal tuff. Thin sections reveal an assemblage of mainly plagioclase (60 to 65 percent), and actinolite, (or rarely hornblende), or biotite (30 to 35 percent) with lesser amounts of epidote, chlorite, quartz, carbonate, and opaque minerals (1 to 5 percent) and minor sphene (less than 1 percent). The mineralogical composition of these metavolcanics is identical to that of the mafic flows. Plagioclase grains in the matrix of samples are too fine grained or altered to yield good determinations of the An content. However, large crystals in three crystal tuffs yielded values of An_{45}, An_{45}, and An_{60}. These grains were slightly altered so the An values obtained may be too low.

Partial whole-rock analyses of three samples were run, and the results were plotted in Figures 2a and 2b. In Figure 2a, one sample plots as a tholeiitic andesite and the other two as calcalkaline basalts. All three plot close to the basalt-andesite boundaries. Their composition is only slightly more felsic than the bulk of the massive and pillowed mafic flows (Table 2).

TABLE 2 CHEMICAL ANALYSES AND MOLECULAR NORMS OF METAVOLCANICS FROM THE TWOPEAK LAKE AREA. CHEMICAL ANALYSES BY MINERAL RESEARCH BRANCH, DIVISION OF MINES.

Major Components in Weight Percent

Sample Number	42	105	106	107	131	137	152	153	157	506	509	537	21	23	145
SiO_2	50.30	55.50	49.10	47.50	46.40	51.20	60.70	50.90	64.40	48.00	49.70	51.20	59.20	50.80	53.30
Al_2O_3	16.10	16.80	13.20	15.50	15.30	16.90	16.40	17.80	13.10	16.00	14.00	18.90	15.60	18.00	15.50
Fe_2O_3	2.14	0.92	1.79	1.30	2.20	2.50	2.40	2.15	2.27	1.60	1.80	2.19	1.16	1.77	1.50
FeO	5.66	7.00	8.47	9.60	10.80	6.84	2.94	7.70	3.08	8.82	12.50	7.00	6.37	7.77	10.20
MgO	8.63	6.79	10.20	11.40	2.72	4.29	3.29	6.89	3.94	10.60	6.87	5.11	3.77	4.69	4.54
CaO	12.90	7.88	12.60	9.78	12.40	9.64	11.10	7.91	11.60	10.80	10.50	8.21	8.65	9.26	7.09
Na_2O	2.34	3.01	2.21	2.31	2.40	4.44	0.96	3.37	0.29	1.91	1.72	2.59	2.83	4.48	3.66
K_2O	0.24	0.12	0.13	0.12	0.31	0.44	0.42	0.29	0.02	0.09	0.19	0.62	0.32	0.89	0.30
TiO_2	0.53	0.80	0.97	0.67	1.99	0.84	0.66	0.96	0.61	0.57	1.03	1.05	0.79	0.60	1.91
P_2O_5	0.09	0.16	0.53	0.10	0.23	0.15	0.16	0.18	0.20	0.09	0.12	0.14	0.22	0.17	0.19
S	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.04	0.01	0.28	0.02	0.01	0.01	0.01	0.01
MnO	0.13	0.11	0.18	0.19	0.27	0.21	0.10	0.16	0.10	0.18	0.21	0.16	0.13	0.16	0.29
CO_2	0.08	0.10	0.05	0.08	3.25	1.12	0.14	0.06	0.05	0.07	0.30	0.43	0.70	1.40	0.10
H_2O^+	1.03	0.95	0.43	1.07	4.75	2.67	1.95	1.47	1.27	1.23	0.75	3.35	1.51	1.99	1.83
H_2O^-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.20	100.10	99.90	99.60	103.00	101.20	101.20	99.90	100.90	100.20	99.70	101.00	101.30	102.00	100.40

Trace Elements in Parts Per Million (PPM)

Cr	700	164	520	520	191	363	165	220	113	460	161	79	27	153	169
Cu	18	47	91	49	32	82	111	62	26	106	100	95	30	46	17
Ni	85	92	113	240	92	129	99	128	44	161	76	44	33	95	40
Zn	40	78	97	90	134	128	62	107	50	83	128	102	182	97	108

Table 2 – Continued

Molecular Norms

Sample Number	42	105	106	107	131	137	152	153	157	506	509	537	21	23	145
Apatite	0.189	0.337	1.114	0.210	0.523	0.321	0.347	0.381	0.436	0.189	0.260	0.304	0.471	0.358	0.409
Pyrrhotite	0.035	0.035	0.035	0.035	0.075	0.036	0.036	0.141	0.036	0.974	0.072	0.036	0.036	0.035	0.036
Ilmenite	0.740	1.122	1.356	0.936	3.009	1.197	0.952	1.354	0.884	0.795	1.487	1.515	1.127	0.841	2.738
Orthoclase	1.422	0.714	0.772	0.712	1.990	2.661	2.573	1.736	0.123	0.533	1.165	3.797	1.937	5.295	1.826
Albite	21.051	27.205	19.911	20.802	23.389	40.768	8.929	30.624	2.710	17.173	16.006	24.079	26.008	35.148	33.810
Anorthite	32.793	32.199	25.811	31.674	32.637	25.458	40.617	32.992	35.792	34.879	31.018	39.476	29.609	26.541	25.709
Magnetite	2.127	—	1.878	1.363	2.497	2.502	2.339	2.275	2.296	1.675	1.951	2.371	1.241	1.862	1.614
Enstatite	9.749	17.233	8.971	6.804	3.337	0.861	4.628	16.978	4.081	12.743	14.973	14.160	7.767	—	11.053
Ferrosilite	2.839	8.482	3.431	2.875	5.679	0.604	1.318	8.217	1.049	4.818	13.370	8.102	6.066	—	11.037
Quartz	—	6.816	—	—	0.851	—	25.976	—	34.394	—	1.962	4.754	15.457	—	4.440
Diopside	19.056	3.276	19.355	9.192	9.628	10.557	9.562	2.988	14.477	10.565	9.370	0.895	5.773	8.312	3.687
Forsterite	3.446	—	7.207	15.124	—	4.480	—	0.585	—	8.461	—	—	—	6.651	—
Fayalite	1.004	—	2.756	6.390	—	3.145	—	0.283	—	3.199	—	—	—	5.232	—
Nepheline	—	—	—	—	—	—	—	—	—	—	—	—	—	3.188	—
Hematite	5.549	1.612	7.403	3.884	16.386	7.410	2.723	1.446	3.722	3.995	8.367	0.512	4.509	6.538	3.681

Footnote:

42 Coarse-grained flow centre, northwest corner of Twopeak Lake.
105 Massive flow, strongly foliated, southwest of Twopeak Lake.
106 Massive flow, strongly foliated, southwest of Twopeak Lake.
107 Massive flow, strongly foliated, southwest of Twopeak Lake.
131 Fine-grained massive flow, northeast of Magiskan Lake.
137 Pillowed flow, northwest of Magiskan Lake.
152 Pillow, epidotized inner core, southwest of Twopeak Lake.
153 Pillow, unaltered outer core, southwest of Twopeak Lake.
157 Pillow, quartz amygdules, epidotized, southwest of Twopeak Lake.
506 Massive flow, southwest of Twopeak Lake.
509 Massive flow, southwest of Twopeak Lake.
537 Undifferentiated, east of Tomlinson Lake.
21 Tuff, massive, northwest of Wasicho Lake.
23 Lapilli-(plagioclase crystals) tuff, northwest of Wasicho Lake.
145 Tuff, massive, northwest of Magiskan Lake.

OGS 9848

Photo 2–Intergrowth of garnet (black) and grunerite (acicular crystals) in a ground mass of granoblastic quartz. Crossed Nicols. Field of view 1.7 mm by 2.4 mm.

METASEDIMENTS

Micaceous Sandstone, Schist, and Iron Formation

An exposure of metasediments 3 km northwest of South Floodwood Lake consists of alternating thick-bedded massive sandstone with thicknesses of as much as 3 m and interlayered thin-bedded sandstone as much as 7 cm thick and schist as much as 2 cm thick. The sandstone units comprise quartz, feldspar, and up to 15 percent biotite, and the schist units comprise quartz, feldspar, and as much as 40 percent biotite. The mica in each unit probably represents former muddy matrix. These rhythmically bedded sandstones and schists are assumed by the author to be the metamorphic equivalents of wackes and mudstones typical of turbidite sedimentation in Archean greenstone belts.

Metasediments exposed just west of the South Floodwood River are microscopically similar to those further to the west, but, examination of thin sections reveals that feldspar is absent. The mineral assemblage includes quartz (35 to 65 percent), biotite (10 to 30 percent), garnet (up to 50 percent) and minor chlorite (less than 1 percent). One thin section contains 20 percent grunerite, a high-iron amphibole (Photo 2). These outcrops are probably identical to iron formation reported in two nearby diamond-drill holes (Resident Geologist's Files,

Ontario Ministry of Natural Resources, Kirkland Lake), and possibly originated, in part, as chemical precipitates. Intersections of iron formation in the Conwest Exploration Company Limited diamond-drill holes are sketchily described in the logs (Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake); one diamond-drill hole is reported to contain some chlorite and grunerite. The presence of biotite and garnet suggests that a mixing of chemical and clastic material occurred.

Weathered surfaces of the micaceous metasediments are light to dark grey and brown, and usually show iron oxide staining. Fresh samples are light to dark grey depending upon the content of biotite. Grain sizes are generally less than 1 mm, but biotite and garnet crystals are as large as 1 mm in length. Micas often define a foliation parallel to the bedding, but a single sample from the outcrop northwest of South Floodwood Lake shows a good foliation perpendicular to the bedding.

Conglomerate, Sandstone, Mudstone, and Iron Formation

Metasediments similar to the micaceous sandstone and schist occur stratigraphically below and within the metavolcanic pile. Although these rocks are occasionally micaceous, especially toward the top of the flows, they are generally chloritic. Alternating thick-bedded coarse-grained units and interlayered thin-bedded coarse and fine-grained units again suggest turbidite sedimentation. The total stratigraphic thickness of the metasediments below the volcanic formation, 0.8 km northwest of Twopeak Lake, is at least 400 m. Metasediment interbeds within the metavolcanics are as much as 25 m thick but average less than 3 m thick.

Two sediment types were recognized in the field. Chemical sedimentary rocks, in some places iron rich, are represented by completely recrystallized thin-bedded, interlayered, quartz-rich and amphibole-rich layers. Quartz-rich layers, comprising up to 95 percent quartz, can contain chlorite, biotite, or actinolite (as much as 20 percent) and epidote, magnetite, carbonate, or garnet (less than 5 percent). Cummingtonite overgrown by hornblende was recognised in one sample. Amphibole-rich layers are almost entirely actinolite or hornblende. The variable content of the quartz-rich layers suggests a mixing of chemical and clastic sedimentary rocks. Intersections of iron formation in a Texas Gulf Sulphur Company diamond-drill hole northwest of Twopeak Lake have been reported (Resident Geologists Files, Ontario Ministry of Natural Resources, Kirkland Lake) to contain chlorite, biotite, garnet, and magnetite.

Clastic sedimentary rocks comprise mainly sandstone with a small amount of pebble and granule conglomerate and mudstone. Sandstone and conglomerate contain lithic and crystal clasts. The lithic clasts are often identifiable in thin sections as tuff or crystal tuff. Crystal clasts were presumably derived from unconsolidated crystal tuff. Occasional quartz-chlorite clasts may be fragments of quartz-rich chemical sedimentary rocks. The mineralogy of samples varies considerably as follows: 45 to 90 percent plagioclase and quartz, as much as 25 percent actinolite (or rarely hornblende), 25 percent chlorite or biotite, 20 percent

TABLE 3 CHEMICAL ANALYSES AND MOLECULAR NORMS OF METASEDIMENTS FROM THE TWOPEAK LAKE AREA. CHEMICAL ANALYSES BY MINERAL RESEARCH BRANCH, DIVISION OF MINES.

Major Components in Weight Percent

Sample Number	55	56	58	74	85	86	87	92	124
SiO_2	45.00	54.00	62.70	72.40	64.10	61.40	61.70	66.20	61.30
Al_2O_3	14.80	7.31	19.50	11.10	15.20	14.10	17.10	16.40	16.50
Fe_2O_3	1.00	0.73	0.60	0.79	0.85	1.70	0.98	0.55	2.18
FeO	10.70	6.23	3.08	4.20	3.99	10.80	2.73	1.61	6.52
MgO	4.59	2.27	1.68	1.20	3.00	3.30	2.77	1.29	2.35
CaO	15.50	17.40	5.35	3.74	4.38	2.07	4.75	3.31	4.42
Na_2O	0.95	0.48	2.42	2.42	2.52	2.17	6.16	6.77	2.96
K_2O	0.44	0.53	2.21	1.55	3.03	2.18	0.76	1.34	1.30
TiO_2	1.14	0.27	0.74	0.34	0.36	0.55	0.49	0.36	1.03
P_2O_5	0.13	0.11	0.18	0.13	0.23	0.21	0.23	0.18	0.24
S	0.03	0.03	0.01	0.01	0.06	0.30	0.03	0.11	0.28
MnO	0.25	0.26	0.06	0.11	0.07	0.11	0.06	0.04	0.20
CO_2	4.95	8.80	0.16	1.27	0.90	0.08	1.30	1.35	0.07
H_2O^+	5.11	11.50	1.91	2.31	2.47	1.47	2.75	2.07	1.23
H_2O^-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	104.60	109.90	100.60	101.60	101.20	100.40	101.80	101.60	100.60

Trace Elements in Parts Per Million (PPM)

Cr	170	12	80	27	97	175	82	22	129
Cu	91	20	6	6	34	55	12	20	52
Ni	59	13	32	14	47	74	44	8	66
Zn	138	106	54	40	89	67	64	42	108

Table 3 – Continued

Molecular Norms

	55	56	58	74	85	86	87	92	124
Apatite	0.296	0.269	0.387	0.287	0.497	0.458	0.483	0.386	0.516
Pyrrhotite	0.113	0.121	0.036	0.037	0.215	1.084	0.104	0.381	0.998
Ilmenite	1.728	0.439	1.058	0.499	0.518	0.798	0.684	0.500	1.473
Orthoclase	2.831	3.656	13.410	9.653	18.507	13.424	4.507	7.904	7.895
Albite	9.280	5.026	22.290	22.878	23.365	20.283	55.454	60.618	27.287
Anorthite	37.893	18.926	26.026	15.634	20.890	9.262	16.816	10.378	20.907
Corundum	—	—	4.290	—	0.406	5.580	—	—	3.097
Magnetite	1.138	0.890	0.644	0.870	0.918	1.850	1.027	0.573	2.304
Wollastonite	—	14.483	—	—	—	—	—	—	—
Enstatite	3.817	—	4.758	3.042	8.553	9.485	6.122	2.134	6.661
Ferrosilite	4.391	—	3.470	5.162	5.152	14.483	2.284	0.773	6.662
Quartz	—	20.419	23.633	39.532	20.979	23.293	8.271	12.500	22.163
Diopside	16.689	14.616	—	0.893	—	—	3.092	2.834	—
Forsterite	1.219	—	—	—	—	—	—	—	—
Fayalite	1.403	—	—	—	—	—	—	—	—
Hematite	19.202	21.155	—	1.516	—	—	1.154	1.027	—

Footnote:

55 Metasediment, interbedded with mafic flows, west of Twopeak Lake.
56 Metasediment, interbedded with mafic flows, west of Twopeak Lake.
58 Metasediment, interbedded with mafic flows, west of Twopeak Lake.
74 Metasediment, interbedded with mafic flows, west of Twopeak Lake.
85 Metasediment, stratigraphically below mafic metavolcanics, northwest of Twopeak Lake.
87 Metasediment, stratigraphically below mafic metavolcanics, northwest of Twopeak Lake.
92 Metasediment, stratigraphically below mafic metavolcanics, northwest of Twopeak Lake.
124 Metasediment, stratigraphically below mafic metavolcanics, northwest of Magiskan Lake.

epidote and 20 percent garnet, and less than 5 percent tourmaline, apatite, hematite, and opaque minerals. The proportion of plagioclase to quartz is generally difficult to estimate owing to the fine grain sizes and a high degree of recrystallization. Plagioclase determinations on large feldspar clasts from three samples yielded compositions from albite or sodic oligoclase to calcic oligoclase (An_{25}, An_{30}, and less than An_{15}). These clastic sedimentary rocks are distinguished from the mafic pyroclastic rocks by the generally higher amount of quartz, and presumably representing former muddy matrix, by chlorite or biotite and garnet, and by the greater variety of clast types.

The metasediments below the volcanic formation are dominantly clastic with only minor amounts of chemical sedimentary rocks. Within the volcanic formation, the proportion of clastic to chemical sedimentary rocks is related to the total sediment thickness. Narrow layers, as much as about 0.5 m thick, are dominantly chemical, while thicker layers are dominantly clastic. No matter what the thickness, interflow sedimentary units are rarely traceable for more than 50 m. This suggests that sedimentation was restricted to small depressions on top of the volcanic pile. The clastic sedimentary rocks were probably derived from consolidated and unconsolidated pyroclastic, hyaloclastic, and erosional volcanic and sedimentary material; the bulk probably came from more elevated areas to the east or northeast.

Weathered and fresh surfaces of these metasediments display extreme variations in colour and texture representing wide variations in composition. Weathered surfaces are white to black and light to dark green and grey-green, usually with brown iron oxide staining. Fresh specimens are light to dark grey and grey-green, dark green, and black. Grain sizes are generally less than 1 mm, though, clasts are occasionally as large as 10 mm.

Beds of chemical sedimentary rocks range from 1 cm to 0.5 m in thickness; clastic layers are as thick as 2 m. Interflow sedimentary units are often recognisable by their differential weathering, strong iron oxide staining, or strong foliation. Stained and foliated zones could, however, be volcanic, and not sedimentary (see section "Mafic Massive and Pillowed Flows").

The result of partial whole-rock analyses are shown in Figure 2a and 2b. Samples plot in Figure 2a from calcalkaline rhyolite to high iron tholeiitic basalt. Compositions of the metasediments are shown in Table 3.

Ultramafic Intrusive Rocks

Peridotite

Few dikes and sills of ultramafic rock were observed intruding the mafic metavolcanics. These intrusive rocks are similar to the coarse-grained mafic flows in colour and texture, and are therefore difficult to recognize in the field; this may account for the small number mapped. The dikes are massive with a very narrow chilled margin and occasionally have very irregular outlines. Thicknesses range from 0.5 m to as much as 2 m and average about 0.5 m. One large sill, with a thickness of about 2 m, is very strongly foliated resulting in a friable outcrop sur-

TABLE 4 | CHEMICAL ANALYSES AND MOLECULAR NORMS OF ULTRAMAFIC INTRUSIVE ROCKS IN THE TWOPEAK LAKE AREA. CHEMICAL ANALYSES BY MINERAL RESEARCH BRANCH, DIVISION OF MINES.

Major Components in Weight Percent

Sample Number	81	101
SiO_2	43.60	48.70
Al_2O_3	10.30	5.34
Fe_2O_3	1.80	2.00
FeO	9.80	10.30
MgO	21.70	19.00
CaO	6.53	9.41
Na_2O	0.27	0.41
K_2O	0.00	0.02
TiO_2	0.49	1.04
P_2O_5	0.09	0.12
S	0.01	0.12
MnO	0.16	0.21
CO_2	0.10	0.12
H_2O^+	5.95	2.71
H_2O^-	0.00	0.00
Total	100.80	99.50

Trace Elements in Parts Per Million (PPM)

Cr	1960	2160
Cu	16	132
Ni	780	1240
Zn	80	68

Molecular Norms

	81	101
Apatite	0.192	0.257
Pyrrhotite	0.035	0.426
Ilmenite	0.697	1.481
Orthoclase	—	0.121
Albite	2.475	3.763
Anorthite	27.464	12.956
Magnetite	1.921	2.137
Enstatite	27.850	37.394
Ferrosilite	6.258	9.287
Diopside	3.277	21.771
Forsterite	23.756	4.005
Fayalite	5.338	0.995
Hematite	0.736	5.407

Footnote:

81 Sill (possible flow), intruding mafic flows, west of Twopeak Lake.
101 Sill or dike, intruding mafic flows, west of Twopeak Lake.

face which contrasts with the more resistant mafic flows. The contact relationship between the sill and the surrounding mafic flows is unclear: the sill couid be interpreted as a flow.

Weathered surfaces are medium to dark green and black, and fresh specimens are medium to dark grey-green. Broken surfaces have a granular and somewhat chalky appearance allowing them to be distinguished in hand specimens from the slightly darker mafic flows. Grain sizes are less than 1 mm. Thin sections reveal mostly tremolite in the fine-grained matrix; tremolite also forms phenocrysts. Minor amounts of opaque minerals and hematite (less than 3 percent) occur.

Partial whole-rock analyses, the results of which are shown in Figures 2a and 2b, give compositions for two samples (Table 4) which are equivalent to the composition of spinifex-bearing ultramafic flows in Munro Township, Ontario (D.R.Pyke, Geologist, Division of Mines, Toronto, personal communication,

1976). One sample plots in Figure 2a as komatiitic peridotite while the other plots as a komatiitic basalt very close to the basalt-peridotite boundary.

Felsic Intrusive Rocks

Granodiorite and Porphyritic Granodiorite

Outcrops of massive to weakly foliated granitic rocks occur throughout the map-area. Weathered surfaces are white to light pink and fresh specimens are light to medium pink. The rocks are predominantly equigranular with grain sizes averaging from 1 to 3 mm. Locally, the rocks are porphyritic with up to 5 percent potassic feldspar phenocrysts as large as 1 cm. An average composition of 22 percent quartz, 54 percent plagioclase, 17 percent potassic feldspar, and 7 percent dark and accessory minerals for the rock was obtained by point counting stained hand specimens. Thin sections reveal the accessory minerals to be chlorite, biotite, apatite, epidote, sphene and opaque minerals. Plagioclase determinations on two sections give a value of An_{22}. Samples of porphyritic granodiorite which intrude the volcanic pile just west of Twopeak Lake are microscopically and macroscopically identical to outcrops of porphyritic granodiorite southeast of Twopeak Lake.

EARLY TO LATE PRECAMBRIAN

Mafic Intrusive Rocks

Diabase

Massive, north-trending post-tectonic diabase dikes, which vary in thickness from 0.5 m to 100 m cut most of the bedrock outcrop within the map area. These dikes are mainly coarse grained (up to 3 mm) and porphyritic; plagioclase phenocrysts are as large as 1 cm. Weathered surfaces are dark green to black, generally with a slight orange tint caused by the presence of iron oxides. Hand specimens are green to dark green and black depending on grain-size; the fine-grained black specimens show diabasic texture. Examination of thin sections reveals: plagioclase An_{50} to An_{55}, about 50 percent; clinopyroxene altering to actinolite (about 40 percent); and minor biotite, epidote, quartz, and opaque minerals (less than 5 percent). In one outcrop northwest of Magiskan Lake, a small east trending diabase dike has cut the north-trending dike. This small dike, which is nearly conformable with the metavolcanics, is identical microscopically to the north-south dikes.

Phanerozoic

CENOZOIC

Quaternary

PLEISTOCENE AND RECENT

The map-area is mantled by a thick cover of ground moraine and lacustrine and outwash deposits (Boissonneau 1965, 1966; Prest 1970). Lacustrine clay and silt were deposited in Glacial Lake Barlow-Ojibway during the waning stages of the Wisconsinan glaciation. Silt, massive clay, and varved clay form smooth plains which are largely peat covered in the southwest and northwest corners of the map-area. In contrast, most of the remainder of the area is covered by ground moraine comprising clay, boulder clay, sand, and gravel. This surface is characterized by drumlinoid landforms and a few peat flats. The ground moraine was deposited on top of Glacial Lake Barlow-Ojibway sediments during the late phase of the Cochrane readvance. A small deposit comprising sand and gravel at the northern end of South Floodwood Lake has been identified by Boissonneau (1966) as an outwash deposit related to esker and glaciolacustrine sediments. This deposit forms a broad, flat plain dotted by a few very small kettle lakes.

Recent deposits consist mainly of organic material which accumulated in swamps and peat flats, and some detrital material deposited in stream beds.

SUMMARY OF MAGNETIC DATA

Data obtained from ground and airborne magnetic surveys has been used to elucidate the geology of the Twopeak Lake Area. Strong positive magnetic anomalies on the aeromagnetic maps (ODM-GSC 1964a,b,c,d,e, and f) are assumed to follow the micaceous metasediments because of the occurrence of iron formation in these rocks. Where ground magnetic surveys (Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake) indicate a linear magnetic high, the approximate location and extent of the anomaly, usually limited by the extent of the survey, has been marked on the map-face (see Map 2410, back pocket). Most reports (Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake) conclude that the north-trending anomalies are caused by diabase dikes, and that anomalies which parallel assumed regional trends are caused by magnetite iron formation.

Aeromagnetic maps (ODM-GSC 1964a,b,c,d,e, and f) also reveal several north-trending lineaments. One such lineament has been shown to connect exposures of dikes southeast of Twopeak Lake and north of Magiskan Lake. Although this lineament could be the result of a single dike as shown on Map 2410 (back pocket), the anomaly may be caused by several parallel or *en echelon* dikes similar to those west of Twopeak Lake.

STRUCTURAL GEOLOGY

Folding

Detailed mapping of the flows west of Twopeak Lake has resulted in a new interpretation of the structure of the area. The structure can be visualized by folding a piece of paper as shown in Figure 4. The synclinal axis of the fold is assumed to plunge northeast in the region northeast of Wasicho Lake. This is indicated by the plunge of minor fold axes both northwest and southeast of Magiskan Lake (Map 2410, back pocket). Southwest of Wasicho Lake, the outcrop pattern indicates that the synclinal axis must be horizontal or plunging to the southwest. The parallelism of the two limbs of the syncline adjacent to the trace of the axial plane and the lack of observed fold closures suggest that the axis is probably almost horizontal. The syncline ends immediately southwest of Twopeak Lake. Southwest of the South Floodwood River, the supracrustal rocks are folded downward about a northwest-trending hinge line.

Assuming that the centre of volcanism was located to the east or northeast of the map-area, rocks which are now close to the trace of the axial plane of the syncline would have been rotated during folding about an axis approximately parallel to the flow direction. Layering in these rocks now parallel the trace of the axial plane. Rocks on the presently northwest-trending parts of the fold, perpendicular to the trace of the axial plane, would have been rotated about an axis approximately perpendicular to the flow direction. Pillows close to and northwest of the fire tower have cross-sections as in Figure 3a (see section on "Massive and Pillowed Flows"); pillows farther to the southwest are oval in cross-section. If the pillows are assumed to be symmetrical in a cross-section taken perpendicular to the flow direction, the differences in pillow shapes in each area may be explained by the different directions of rotation during folding.

The syncline is flanked on either side by anticlines, or more properly, elongate domes. Bedrock on the northern limb of the northern dome, northwest of Magiskan Lake, is isoclinally folded about northeast-plunging axes. Folding with wavelengths and amplitudes of less than 0.5 m may be observed on outcrop surfaces, while larger scale folding is evident in changes in the strike and dip of foliation and bedding. As a consequence of this, contacts in this area may be offset in map view by "Z" shaped folds. Such offsets cannot be located with certainty from the field data.

Metasediments at the base of the supracrustal succession are exposed on the edge of the northern dome, but not at the edge of the southern dome. This could be caused by lack of exposure on the edge of the southern dome, or to some asymmetry in the original pattern of sedimentation; the cause cannot be determined from the present data.

Figure 4–Diagram to show structure of the supracrustal rocks.

Foliation and Lineation

Rocks in the Twopeak Lake map-area are foliated generally parallel to bedding directions. Mineral lineations and directions of major pillow elongation pitch 90° on foliation surfaces. Boudinaged small dikes, quartz veins, and flow layering, pervasive foliation, and minor elongation of pillows parallel to foliation may have resulted from pure or simple shear during the folding of the supracrustal rocks. West of Twopeak Lake, strongly foliated zones commonly contain small scale "S" and "Z" folds, but no significant pattern of folding, as would be expected in areas of homogeneous simple shear, was observed.

No faults were observed in the Twopeak Lake map-area.

GEOLOGICAL HISTORY AND REGIONAL SYNTHESIS

Pillow shapes, as discussed in the section "Mafic Massive and Pillowed Flows", suggest that a centre of volcanism existed to the east or northeast of the Twopeak Lake map-area. Assuming that this was so, and that the oldest rocks in the Twopeak Lake area were granitic (Baragar and McGlynn 1976), the accumulation of the supracrustal sequence in the area commenced with the deposition of volcaniclastic sediments on the granitic basement. These sediments could have been derived from a growing volcanic edifice to the east or northeast. Eventually, the mafic flows spread to cover these sediments. Sedimentation continued to leave small deposits between flows. Later stages of volcanism must have involved a large amount of pyroclastic debris which is indicated by the thick section of tuff above the flows northwest of Magiskan Lake. The last stages of volcanism were followed by a period of erosion and the deposition of sediments presently represented by the micaceous metasediments.

The supracrustal succession was modified by later, or possibly contemporaneous deformation and low-grade metamorphism. Deformation may have been gravity-driven as discussed by Ramberg (1967, Chapter 12). Ramberg's Figure 86 shows a subsiding body having a uniform thickness which was deformed to form an inverted "U" shape in cross-section. Assuming that Archean volcanic piles were thicker close to the centre of volcanism than at the edges, the supracrustal rocks might have been expected to sink rapidly near the centre to form an "M" shape in cross-section as in Figure 2, Gorman *et al.* (1978a). This is what could have occurred in the Twopeak Lake area. A cross-section drawn along a northwest-trending line through Springer Lake would show a central syncline of metavolcanics and metasediments flanked on each side by anticlines cored by granite and capped by metavolcanics and metasediments. The granitic rocks coring the anticlines would have been remobilized when the supracrustal rocks subsided. The northern limb of the northern anticline would show folding similar to that shown by Ramberg (1967, Figure 95B and C). A cross-section drawn in a northeasterly direction through the northern end of Twopeak Lake would show a rough inverted "U" shape with the supracrustal rocks west of the South Floodwood River folded downward about a northwest-trending hinge and the main synclinal axis plunging to the east and northeast.

Regional aeromagnetic maps (ODM-GSC 1964a,b,c,d,e, and f) indicate that the supracrustal rocks may have been folded in two other northeast-plunging synclines southeast of the map-area. One of these synclines begins at the southeast corner of the map-area trending northeast through Tomlinson and Hurtubise Townships (Figure 5, Chart A, back pocket). In Hurtubise Township, a pair of magnetic highs flanking the Kabika River may be on opposite sides of the syncline. The second begins in the northeast corner of Kenning Township, trending northeast through Singer, Hurtubise, and St. Laurent Townships. Pairs of magnetic highs at the boundary of Hurtubise and St. Laurent Townships may also be on opposite sides of this syncline. The southwest terminations of these synclines may be seen in more detail in aeromagnetic maps submitted by Dome Exploration (Canada) Limited (Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake). This folding hypothesis is not inconsistent with outcrop data shown by Bennett *et al.* (1966).

The author's theory is that a single sheet of supracrustal volcanic and sedimentary rocks subsided into the granitic basement, and was folded into three northeast-plunging synclines flanked by elongate domes of granite. This sheet may have been continuous with the volcanic and sedimentary rocks of the Timmins-Kirkland Lake Area to the south and the Detour Lake area to the north.

ECONOMIC GEOLOGY

The first claims recorded in the Twopeak lake map-area were staked in 1940 near West Porphyry Lake. Other claims were recorded in 1956, 1960, between 1964 and 1969, and from 1973 to the present time. In November 1976, claims in good standing were held by Dome Exploration (Canada) Limited, Geophysical Engineering Limited, Hudson Bay Exploration and Development Company Limited, and Noranda Exploration Limited.

Bedrock exposures are rare, consequently most exploration has been done by geophysical methods. Diamond drilling of magnetic and electromagnetic anomalies has located mainly iron formation, graphitic sedimentary rocks, and massive to disseminated pyrite and pyrrhotite. The iron formation is about 43 m thick west of Twopeak Lake, but is possibly much thinner elsewhere. Graphitic sedimentary rocks, including graphitic shale, slate, argillite, and reworked tuffs, are common throughout the metavolcanic-metasedimentary section. Pyrite and pyrrhotite are abundant in several diamond-drill holes and are present in almost all the diamond-drill holes. Chalcopyrite has been reported in minor amounts in five diamond-drill holes, from just one speck to multiple small intersections. Assays of sulphide minerals and quartz veins have not shown any metal concentrations of economic importance.

Accessory amounts of pyrite and pyrrhotite are common in hand specimens taken from the map-area; no other metallic minerals were observed. Zones on outcrops stained by iron oxide delineate metasediments or strongly foliated metavolcanics, or contact zones of diabase dikes. It has been suggested, see section on "Noranda Exploration Limited (9)", that the intrusion of the diabase resulted in remobilization and concentration of sulphide minerals at these contacts.

Ground magnetic surveys indicate that the magnetite iron formation is most common near the base of the micaceous metasediments. Ground electromagnetic surveys indicate that most conductors are within the lower part of the micaceous metasediments and the upper part of the mafic metavolcanics which probably consist of pyroclastic and metasedimentary deposits. For this reason, exploration activity has centred on the metavolcanic-micaceous metasediment contact zone.

The volume of felsic pyroclastic rocks, a rock-type often associated with volcanogenic massive sulphide ore deposits, is very low. Narrow beds of rhyolitic to dacitic reworked pyroclastic material may be found in the metasediments below the volcanic sequence and in metasedimentary layers interbedded with the mafic massive and pillowed flows.

Description of Properties and Occurrences

Current and defunct properties for which geological or related information is available in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake, are listed in this report. Properties are located on the map-face by numbers corresponding with those with each company name. The numbers indicate the approximate centres of claim groups, or for larger blocks, the approximate area covered. Locations of diamond-drill holes are only approximate.

CANNON MINES LIMITED [1967] (1)[1]

In 1967 Cannon Mines Limited investigated a property located 4.8 km south of Twopeak Lake comprising 25 contiguous claims underlain by metavolcanics and metasediments. Outcrops of bedrock within the claim group include mafic massive and pillowed flows with minor amounts of interbedded metasediments. A vertical loop electromagnetic ground survey showed two very minor conductors. The survey report concluded that no conductors of interest exist within 46 m of the surface. A magnetic ground survey revealed one east-trending anomalous ridge that indicated the presence of bedded iron formation. No further work has been reported on these claims, and the claim group was allowed to lapse.

CONWEST EXPLORATION LIMITED [1960] (2)

In 1957, Conwest Exploration Limited held 87 contiguous claims in Newman and Bragg Townships 4.8 km southwest of Twopeak Lake. In that year, a ground magnetic survey was run covering parts of 30 of these claims, an area

[1]Number in parentheses refers to property numbers shown on Map 2410, back pocket.

which is underlain by metavolcanics and metasediments. Bedrock exposure is limited to a few small outcrops of micaceous metasediments at the northern end of the claim group. The magnetic survey showed a strong positive northwest-trending continuous anomaly, which, the report concluded, was the result of magnetite iron formation. Follow-up diamond drilling, completed in about 1959, totalled a length of 356 m in two diamond-drill holes. These diamond-drill holes intersected magnetite iron formation over 58 and 66 m but no sulphide minerals were reported. These claims were allowed to lapse.

A second claim group in Blakelock Township just northwest of Magiskan Lake consisted of 63 contiguous claims; about 51 of them are within the Two-peak map-area. The group is underlain by metavolcanics and metasediments, with outcrops of mafic flows and tuffs, and metasediments in the south-central claims. A horizontal loop electromagnetic ground survey run in 1959 revealed one broad, northwest-dipping highly conductive zone in the south-central part of the claim group. This zone was interpreted by Conwest Exploration Limited to result from several closely-spaced narrow, parallel conductors. In 1959, diamond drilling totalling a length of 473.7 m in four diamond-drill holes in 1959 intersected graphitic argillite, minor magnetite, and minor disseminations and stringers of pyrite and pyrrhotite. A geological report with a map at a scale of 1 inch to 400 feet submitted in 1960 (Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake) stated that the diamond-drilling was follow-up work done after airborne electromagnetic and magnetic surveys. Reports from these are not available in the Assessment Files Research Office, Division of Mines, Toronto. The geological report concluded that the electromagnetic anomalies resulted from stringers of pyrite and pyrrhotite which parallel the schistosity and are mainly associated with metasediments. Assays of the sulphide minerals, for which no figures are available, are reported to have been discouraging. These claims were allowed to lapse.

DOME EXPLORATION (CANADA) LIMITED (3)

In November 1976, Dome Exploration (Canada) Limited held 78 claims numbered L420931 to L420939 inclusive, L420981 to L420992 inclusive, L429548 to L429556 inclusive, L429595 to L429619 inclusive, and L429659 to L429681 inclusive within the map-area, grouped in two blocks in the southeast corner. Magnetic and horizontal loop electromagnetic ground surveys were run on 14 of a group of 18 claims 4.8 km southwest of Bateman Lake. Although no bedrock is exposed at the surface, this area is interpreted by the author to be underlain by metavolcanics and metasediments. The surveys showed that two main conductive zones coincident with magnetic anomalies occur, in the northwest and southwest corners of the claim group. These zones trend approximately east. The company report suggests that the northern anomaly indicates the presence of sulphide mineralization and that the southern anomaly may indicate the presence of sulphide minerals and/or graphite. An airborne magnetic survey, for which a report and map (scale 1 inch to 1320 feet) are available in the Resident Geologist's Files, Ontario Ministry of Natural Resources, was flown in 1975. This survey covers parts of the southern edges of Newman and Tomlinson Townships.

EAGLE HEAD MINES LIMITED [1967] (4)

A group of ten claims 7.2 km southwest of Twopeak Lake was examined by Eagle Head Mines Limited in 1967 using magnetic and vertical loop electromagnetic ground surveys. The author interprets this claim group to be underlain by metasediments. No bedrock outcrops exist within the boundaries of the claim group. The magnetic survey showed a single east-trending anomaly which the report suggested was caused by magnetite iron formation. The electromagnetic survey found no discrete conductors. These claims were allowed to lapse.

FORCE CRAG MINES LIMITED [1968] (5)

Force Crag Mines Limited examined 13 contiguous claims 5.6 km southwest of Floodwood Lake by means of electromagnetic (VLF) and magnetic ground surveys in 1968 (Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake). The underlying rocks are interpreted by the author to be metavolcanics and metasediments, but no rocks outcrop within the claim group. The electromagnetic survey showed no anomalies, while the magnetic survey located only one northwest-trending magnetic high at the east end of the group. No further work was reported and the claims were allowed to lapse.

GEOPHYSICAL ENGINEERING LIMITED (6)

In November 1976, Geophysical Engineering Limited held 45 claims in four groups within the map-area. These groups consist of: a group of eight claims numbered L362674 to L362680 inclusive 5 km south of Bateman Lake; a group of ten claims numbered L393354 to L393363 inclusive, 1.5 km east of Magiskan Lake; a group of four claims numbered L393328 to L393331 inclusive, 1.6 km east of Floodwood Lake; and a group of 19 claims numbered L437660 to L43762 inclusive, and L437848 to L437863 inclusive, 2.4 km northwest of Magiskan Lake. No assessment work had been submitted for these properties in 1976.

HUDSON BAY EXPLORATION AND DEVELOPMENT COMPANY LIMITED (7)

Hudson Bay Exploration and Development Company held 239 claims in ten group on November 1976. The groups consist of the following: a group of 13 claims numbered L475870 to L475882 inclusive, just north of West Porphyry Lake; a group of four claims numbered L476035 to L436038 inclusive, 3.2 km southwest of West Porphyry Lake; a group of four claims numbered L475907 to L475910 inclusive, 1.5 km northeast of Floodwood Lake; a group of 18 claims numbered L475889 to L475906 inclusive, 1.5 km southeast of Floodwood Lake; a group of 28 claims numbered L475978 to L475987 inclusive, L475990 to L475999

inclusive, and L476087 to L476094 inclusive, 1.5 km north of Floodwood Lake; a group of 48 claims numbered L476039 to L476086 inclusive, 3.2 km northwest of Floodwood Lake; a group of 82 claims numbered L475839 to L475869 inclusive, L475939 to L475949 inclusive, L475954 to L475967 inclusive, L475989 and L476000 to L476024 inclusive, extending from 11.3 km northwest of Twopeak Lake to within 1.5 km of Twopeak Lake, a group of four claims numbered L475950 to L475953 inclusive, 8 km west of Twopeak Lake; a group of 34 claims numbered L476095 to L476128 inclusive, 5 km southwest of Twopeak Lake; and a group of four claims numbered L475883 to L475886 inclusive, 1.5 km (1 mi) southwest of Bateman Lake. No assessment work was submitted for these properties in 1976.

MOVADO MINING COMPANY LIMITED [1968] (8)

Movado Mining Company Limited held an 18 claim group 3 km northwest of South Floodwood Lake. This group of claims is probably underlain by metavolcanics and metasediments. No surface exposures of bedrock have been found. Electromagnetic (VLF) and magnetic ground surveys done in 1967 did not detect good conductors, and found only one magnetic anomaly in the east-central part of the claim group. This anomaly comprised seven smaller east-trending anomalies. Two diamond-drill holes which were collared in 1968, but for which no logs are available in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake totalled 300 m in length. It was reported that these diamond-drill holes intersected interbedded metavolcanics and metasediments and two sulphide sections of unreported dimensions in each hole. Assays in one hole showed 0.14 percent copper, 0.02 percent zinc, traces of lead and nickel, and no silver or gold over a total length of 1.6 m of sulphide core analysed. Assays in the other diamond-drill hole showed 0.21 percent copper, 0.08 zinc, traces of lead, nickel, and silver, and no gold over a total of 9 m of sulphides analysed. These claims were subsequently allowed to lapse.

NORANDA EXPLORATION LIMITED (9, and 10)

In 1974, magnetic and electromagnetic ground surveys were run on a total of 104 claims in 12 groups. A group of 12 claims, of which the six easternmost numbered L374378 to L374383 inclusive were still held by Noranda Exploration Limited in November 1976, was located 5 km south of Twopeak Lake. Although no surface exposure of bedrock has been found, the present study indicates that these claims are probably underlain by metavolcanics and metasediments. A horizontal loop electromagnetic ground survey revealed several parallel east-trending conductors. The most southerly conductor is associated with the only ground magnetic anomaly found, and was assumed by Noranda Exploration Limited to result from magnetite iron formation (Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake).

A horizontal loop electromagnetic ground survey carried out on a group of

nine claims 1.5 km southwest of Bateman Lake, found two short, east-trending conductors; both had a magnetic expression. A third ground magnetic high revealed the presence of a north-striking diabase dike. No bedrock outcrops within the claim group, which in the present study, is interpreted to be underlain by metavolcanics and possibly granite. These claims have been allowed to lapse.

On an eight-claim group located 5 km west of Twopeak Lake, a vertical loop electromagnetic ground survey located one north dipping, strongly conductive zone striking a little north of west. This zone, which was coincident with a ground magnetic high, was assumed by Noranda Exploration Limited to be due to graphite and sulphide minerals. No other ground magnetic anomalies were found. In this claim group, interpreted by the author to be underlain by metavolcanics, bedrock exposures include outcrops of massive and pillowed mafic flows and minor interbedded metasediments. This claim group has been allowed to lapse.

Only one magnetic anomaly was found on a group of four claims numbered L381371 to L381374 inclusive, 1.5 km northeast of Wasicho Lake. These claims interpreted to be underlain by metavolcanics and metasediments were still held by Noranda Exploration Limited in November 1976. A vertical loop electromagnetic ground survey located one broad, weakly conductive zone, which, because it was not associated with a magnetic high, was reported to be possibly associated with carbonaceous sedimentary rocks. No bedrock outcrops are exposed within the claim group.

Magnetic and vertical loop electromagnetic ground surveys showed the presence of a north-striking diabase dike and a very weak east-trending conductive zone on a group of six claims 1.5 km southwest of Floodwood Lake. The present mapping indicates that these claims are underlain by metavolcanics. No outcrops of bedrock have been found. This claim group has been allowed to lapse.

A group of eight claims numbered L381363 to L381370 inclusive located at the northwest corner of Floodwood Lake, is interpreted here to be underlain by metavolcanics and associated metasediments. The overburden is thick in this region, and no bedrock outcrops have been found. A magnetic ground survey indicates possible bedrock trends of N75°E at the north edge of the claim group and a possible "Z" fold in the southeast corner. These anomalies were considered by Noranda Exploration Limited to be caused by high concentrations of pyrrhotite and/or magnetite in iron formation. A vertical loop electromagnetic ground survey showed numerous zones of conductivity having considerable strike lengths which the survey report suggests may be caused by graphitic horizons in metasediments. These claims were still held by Noranda Exploration Limited in December 1976.

Nine out of a group of 18 claims lie within the map-area, 5.6 km southeast of Bateman Lake. This group is interpreted by the author to be underlain by metavolcanics. However, no surface exposures are known. A magnetic survey revealed a few zones only slightly above background and a vertical loop ground electromagnetic survey located two east-trending conductors with no associated magnetic expressions. These claims were allowed to lapse.

A group of six contiguous claims numbered L380972, L380973 and L381539 to L381362 inclusive, was located just west of West Porphyry Lake. This area, interpreted by the author to be underlain by metavolcanics and metasediments, includes two reported bedrock outcrops (Resident Geologist's Files, Ontario Min-

istry of Natural Resources, Kirkland Lake), one is composed of mafic metavolcanics 240 m to the north of the Noranda Exploration Limited grid and one is composed of metasediments 120 m to the south of this grid. These outcrops were not located by the author or by the report submitted to the Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake. A vertical loop ground electromagnetic survey showed one strong conductive zone trending just north of east. A ground magnetic survey located two linear highs running parallel to the conductor, but are not associated with it. These claims were still held by Noranda Exploration Limited in November 1976.

An eleven-claim group was held 1.5 km north of Magiskan Lake. This group is interpreted here to be underlain by metavolcanics as indicated by surface exposures of mafic flows and tuffs. Two north-trending diabase dikes, including the one exposed on the surface, were revealed by the ground magnetic survey. A vertical loop ground electromagnetic survey showed only one significant conductor trending about N75°E roughly parallel to the local foliation and layering. The report by Noranda Exploration Limited suggests that the conductive zone may be a result of remobilization and concentration of sulphide minerals resulting from the intrusion of a diabase dike. No further work has been reported, and the claims have been allowed to lapse.

Four claims border on the Mikwam River at the northern edge of the map sheet. Although no bedrock outcrops were seen, this area was interpreted by the author to be underlain by metavolcanics. A ground magnetic survey showed the presence of two north-trending diabase dikes and trends of about N30°E in the metavolcanics. Only one weakly conductive zone, with no associated magnetic expression, was found by the vertical loop ground electromagnetic survey. These claims were allowed to lapse.

Three out of a group of nine claims lie within the map area 5 km northwest of Magiskan Lake. These three claims have been allowed to lapse, however, Noranda Exploration Limited held the other six as of November 1976. The claims, containing no known exposure of the bedrock, were interpreted by the author to be underlain by metavolcanics. The ground magnetic and vertical loop electromagnetic surveys showed one northeast-trending, broad magnetic high which was highly conductive in places. This data enabled the presence of magnetite, pyrite, pyrrhotite and graphite in the bedrock to be inferred by the company report (Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake).

Noranda Exploration Limited held a group of nine claims 1.5 km east of Mego Lake. These claims are interpreted by the author to be underlain by metavolcanics which are not exposed at the surface. A ground magnetic survey revealed a north-striking diabase dike and some localized magnetite enrichment. A ground vertical loop electromagnetic survey found no significant conductors. The company has allowed this claim group to lapse.

RAEJAC EXPLORATIONS LIMITED [1968] (11)

Raejac Exploration Limited held an 18 claim group 5.6 km southwest of Floodwood Lake. This property, which is interpreted by the author to be under-

lain by metavolcanics and metasediments, includes at it's eastern edge, exposures of massive and pillowed mafic flows and associated interbedded metasediments. A magnetic ground survey showed a large, northwest-trending anomaly in the southwest corner of the claim group. An electromagnetic ground survey (VLF) located several conductors in the eastern part of the group. Follow-up diamond drilling done in 1968, totalled a length of 306 m in two holes, and revealed only minor pyrite and pyrrhotite in greywacke. Assays on three samples showed no more than a trace of any metal except iron which reached 5 to 15 percent. Sulphide minerals were intersected over 6.4 m and 6.7 m in one diamond-drill hole and over 0.1 m in the other. Assay samples were taken over 0.6 and 0.1 m. No further work has been reported and these claims have been allowed to lapse.

SUMMIT EXPLORATIONS AND HOLDINGS LIMITED [1967] (12)

Summit Explorations and Holdings Limited was formed in September 1969 by the amalgamation of five companies, one of which was Kelly-K Mines Limited. In 1967, Kelly-K Mines Limited examined a block of ten claims 5 km southwest of Twopeak Lake. These claims are interpreted in this study to be underlain by metavolcanics and metasediments. Outcrops of bedrock include mafic massive flows, pillowed flows, tuffs, and interbedded metasediments. A ground magnetic survey revealed a number of anomalies, one of which trended north and was interpreted by the company to be a diabase dike. A northwest-trending magnetic high in the southwest corner of the group was interpreted to be magnetite iron formation. A vertical loop electromagnetic ground survey showed strong conductors along the length of the diabase dikes. Follow-up diamond drilling totalling a length of 460 m was completed in three holes by Kelly-K Mines Limited in 1967. One diamond-drill hole intersected considerable amounts of pyrite and pyrrhotite with very minor chalcopyrite in a 77 m section of quartzite, but the other drill holes showed only minor pyrite and pyrrhotite. Assays of six samples of sulphide minerals taken by Kelly-K Mines Limited over a total of 6.7 m (22 feet) produced titanium values of 0.2 to 0.5 percent and values for all other metals of less than 0.1 percent. These claims were allowed to lapse by Summit Explorations and Holdings Limited.

TEXAS GULF SULPHUR COMPANY INCORPORATED [1967] (13)

In 1967, Texas Gulf Sulphur Company Incorporated held several claim groups within the map area. A total length of 1604.0 m of rock was diamond-drilled in 15 holes on eight of those groups.

Two diamond-drill holes totalling a length of 181.0 m drilled on a group of nine claims 5 km southeast of Bateman Lake revealed pyrite with minor pyrrhotite in dacitic tuffs and flows, graphitic tuff, argillite, and shale. Bedrock is not exposed in this claim group which is interpreted by the author to be underlain by metavolcanics and associated interbedded metasediments. These claims have been allowed to lapse.

Just north of these diamond-drill holes at Tomlinson Lake, two holes with a total length of 196 m were collared in a group of six claims, a group which is interpreted by the author to be underlain by metavolcanics and associated interbedded metasediments. An outcrop of mafic to intermediate tuff is located at the southeast corner of the group. The diamond-drill holes intersected dacite and graphitic tuff which contained, in one drill hole, many sections of pyrite and minor pyrrhotite. Sulphide values varied between 5 and 20 percent over 19 m. These claims have been allowed to lapse.

A single diamond-drill hole collared in a group of eight claims 4.8 km southwest of Twopeak Lake intersected only minor amounts of disseminated pyrite and pyrrhotite in greywacke and tuff. These claims, interpreted here to be underlain by metasediments, include no known exposures of bedrock. The claims have been allowed to lapse.

Two diamond-drill holes totalling 164 m were drilled on a group of 12 claims 5 km southwest of Twopeak Lake. Outcrops of massive and pillowed mafic flows and micaceous metasediments may be found within the claim group. The diamond-drill holes intersected pyrite and pyrrhotite in interbedded tuff and greywacke, including a 1 m conductor composed of 60 percent massive pyrite associated with graphitic sedimentary rocks. The claims have been allowed to lapse.

A pair of diamond-drill holes totalling 154 m were drilled on a group of four properties 3 km west of Twopeak Lake. This group, which is interpreted here to be underlain by metasediments and metavolcanics includes exposures of mafic massive flows and pillowed flows and associated interbedded metasediments. The diamond-drill holes intersected up to 30 percent pyrite and pyrrhotite in tuff, graphitic sedimentary rocks including greywacke, shale, and argillite, and chloritic greywacke. An irregular blotchy to banded iron formation was intersected over 3.4 m. These claims were allowed to lapse.

A diamond-drill hole 62 m in length drilled 5 km west of Floodwood Lake intersected a conductor containing 70 percent pyrrhotite over a length of 0.2 m and 20 percent pyrrhotite and 50 percent pyrite over the next 1.1 m. The sulphide minerals were associated with metagreywacke, the dominant rock type intersected. The claim group, which is barren of bedrock exposures , is probably underlain by metasediments and possibly, closer to its eastern edge by metavolcanics. This claim group has been allowed to lapse.

Just 0.8 km north of this diamond-drill hole three diamond-drill holes totalling 505.0 m in length were drilled on a group of 18 claims. A fourth hole diamond drilled on this group lies just west of the map-area. The three diamond-drill holes intersected considerable pyrite and pyrrhotite in meta-andesite, andesitic tuff, arenaceous and quartzitic sedimentary rocks, greywacke, graphitic shale, and argillite. Chalcopyrite was also found but only in traces or very small amounts in meta-andesite, andesitic tuff, greywacke, undifferentiated tuffs, and metasediments. In one of these diamond-drill holes sulphide minerals were common in all rock types over a length of 138 m. Chalcopyrite, however, occurred only in trace amounts, and values for pyrite and pyrrhotite rarely exceeded 10 percent. This claim group, interpreted here to be underlain by metasediments, and metavolcanics has been allowed to lapse.

Minor pyrite and pyrrhotite were found in two diamond-drill holes totalling 247 m in length in a group of six claims 2.4 km southwest of West Porphyry Lake. These sulphide minerals, which reached values of no more than 10 to 15

percent over 1.7 m, occurred in tuff and undifferentiated metasediments (Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake). Traces of chalcopyrite were found in 2.5 cm long blebs of quartz at only one horizon in tuff. This claim group is interpreted by the author here to be underlain by metasediments and metavolcanics: however, no outcrops of bedrock have been found. The claim group has been allowed to lapse.

TRIPOINT MINES LIMITED [1967] (14)

Tripoint Mines Limited held a group of ten claims 5 km southwest of Twopeak Lake. These claims, on which there is a single known outcrop of mafic flows, are interpreted by the author to be underlain mainly by metasediments with minor interbedded metavolcanics. A magnetic ground survey located two, strong, northwest-trending anomalies which Tripoint Mines Limited assumed were caused by magnetite iron formation. A vertical loop electromagnetic ground survey located one conductor in the northeast corner of the claim group. Follow up diamond drilling of the conductor was completed in 1967. The 152 m long diamond-drill hole encountered minor pyrite and pyrrhotite in a 1 m long section of graphite and a 0.3 m length of disseminated pyrite in quartz. Assays of two quartz veins showed traces of gold, 1 percent titanium, and less than 0.1 percent of other metals. No further work has been reported and the claim group has been allowed to lapse.

SUGGESTIONS FOR EXPLORATION

Volcanogenic massive sulphide deposits can be expected to be found in pyroclastic or sedimentary material. Within the map-area, the best exploration target for base metals appears to be about the contact zone of the metavolcanics and the micaceous metasediments, a zone where pyroclastic mafic volcanic rocks, volcaniclastic metasediments, and iron formation are common. This contact zone may be followed from the southeast corner of the map-area, around Twopeak and Floodwood Lakes, and then to the northeast beyond the area. Isoclinal folding of the north limb of the north dome proposed by the author may result in repeated outcropping of the contact. The contact may also outcrop east of the map-area in the core of the syncline when and if the synclinal axis reaches greater depths. If, as the author has suggested, the volcanic centre was located east of the map-area, the possibility exists of greater volumes of felsic to intermediate metavolcanics located there. This region could be a favourable exploration target.

REFERENCES

Baragar, W. R. A., and McGlynn, J. C.
1976: Early Archean Basement in the Canadian Shield; A Review of the Evidence; Can., Geol. Surv., Pap. 76-14, 20p.

Bennett, G., Brown, D., and George, P.
1966: Burntbush River Sheet, District of Cochrane, Ont. Dept. Mines, Prelim. Geol. Map No. P.373, scale 1 inch to 2 miles. Geology 1966.

Bennett, G., Brown, D.D., George, P.T., and Leahy, E.J
1967: Operation Kapuskasing; Ont. Dept. Mines, MP10, 98p.

Boissonneau, A.N.
1965: Algoma-Cochrane Sheet, Surficial Geology; Ont. Dept. Lands and Forests, Map 5365, scale 1 inch to 8 miles (1:506,880).
1966: Glacial History of Northeastern Ontario, 1: The Cochrane Hearst Area; Can. J. Earth Sci., Vol.3, p.559-578.

Gorman, B.E., Pearce, T.H., and Birkett, T.C.
1978: On The Structure of Archean Greenstone Belts, Precambrian Res., Vol.6, p.23-41.

Jensen, L.S.
1976: A New Cation Plot for Classifying Subalkalic Volcanic Rocks; Ont. Div. Mines, MP66, 22p.

ODM-GSC
1964a: Whitewater River Sheet, Cochrane District, Ontario; Ont. Dept. Mines–Can., Geol. Surv., Aeromagnetic Map 2356G, scale 1 inch to 1 mile. Survey May 1963 to April 1964.
1964b: Twopeak Lake Sheet, Cochrane District, Ontario; Ont. Dept. Mines–Can., Geol. Surv., Aeromagnetic Map 2357G, scale 1 inch to 1 mile. Survey May 1963 to April 1964.
1964c: Burntbush Lake Sheet Cochrane District, Ontario; Ont. Dept. Mines–Can., Geol. Surv., Aeromagnetic Map 2358G, scale 1 inch to 1 mile. Survey May 1963 to May 1964.
1964d: Abbotsford Lake Sheet, Cochrane District, Ontario; Ont. Dept. Mines–Can., Geol. Surv., Aeromagnetic Map 2366G, scale 1 inch to 1 mile. Survey May 1963 to April 1964.
1964e: Payntouk Lake Sheet, Cochrane District, Ontario; Ont. Dept. Mines–Can., Geol. Surv., Aeromagnetic Map 2367G, scale 1 inch to 1 mile. Survey May 1963 to April 1964.
1964f: Chabbie Lake Sheet, Cochrane District; Ont. Dept. Mines–Can., Geol. Surv., Aeromagnetic Map 2368G, scale 1 inch to 1 mile. Survey May 1963 to April 1964.

Prest, V.K.
1970: Quaternary Geology of Canada; p.675-764 *in* Geology and Economic Minerals of Canada, Edited by R.J.W. Douglas, Can., Geol. Surv., Econ. Geol. Rep. No.1, 838p.

Ramberg, H.
1967: Gravity, Deformation, and the Earth's Crust; Academic Press, New York, 214 pages.

Thomson, R.
1936: Geology of the Burntbush River Area; p.49-50 *in* Ont. Dept. Mines Ann. Rept. Vol.45, Pt.6, p.49-70. Accompanied by Map 45e, scale l inch to 2 miles.

INDEX

PAGE

Almandine garnet 3
Analyses:
  Chemical:
    Chloritic metasediments, discussion . .4
    Flows, discussion. 9,10
    Mafic intrusive rocks 19
    Mafic pyroclastic rocks, discussion . .11
    Metasediments 16-17
    Metavolcanics. 12-13
      Discussion 3
    Ultramafic rocks, discussion 5
  Norms:
    Mafic intrusive rocks 19
    Metasediments 16-17
    Metavolcanics. 12-13
  Trace elements:
    Mafic intrusive rocks 19
    Metasediments 16-19
    Metavolcanics. 12-13
Andesite 3,5
  Tholeiitic. 11
Anticlines 24
Apatite 18
Assays:
  Copper 29
  Gold 34
  Lead 29
  Nickel. 29
  Silver 29
  Sulphide minerals 25,27
  Titanium 32,34

Barlow-Ojibway, Glacial Lake 21
Basalt 3
  Calc-alkaline. 11
Bateman Lake. 27,28,29,30,32
Blakelock Tp. 27
Boudinaged layers:
  Photo 10
Boudins. 9
Bragg Tp. 26

Calc-alkaline basalt 11
Chalcopyrite. 25,32,33,34
Chemical sedimentary rocks:
  Texture 15
Clastic sedimentary rocks:
  Texture 15
Clasts:
  Crystal 15
Clay:
  Lacustrine 20
  Massive 20
  Varved 20
Cochrane readvance. 21
Contact relationship:
  Sill-mafic flows. 19
Conwest Expl. Co. Ltd. 15,27
Cummingtonite. 15

PAGE

Deformation, gravity driven. 24
Diabase 20,31,32
Dikes:
  Circular intrusion 11
  Diabase 20,31,32
  Feldspar porphyry. 10
Dome Expl. (Canada) Ltd. 25
Domes. 22
Drumlinoid landforms 21

Feldspar porphyry dikes. 10
Felsic pyroclastic rocks. 26
Floodwood Lake. 28,29,30,31,33,34
Flow morphology, mafic flows. 7
Flow thicknesses 11
Flows:
  Direction and growth 8,9
  Massive and pillow, texture 9
Folds:
  "Z shaped" 22

Gabbroic rock:
  Irregular bodies. 7
  Stringers 7
Garnet. 14,15,18
  Almandine 3
  Photo 14
Geological contacts, nature of 6
Geological history, author's theory. 24-25
Geophysical Engineering Ltd. 25
Geophysical Surveys . . 26,27,28,29,31,32
Glacial Lake Barlow-Ojibway. 21
Granodiorite. 20
Graphite 27,30,31
Graphitic sedimentary rocks 25
Ground moraine 21
Grunerite. 14
  Photo 14

Hematite 18,19
Hudson Bay Expl. and Dev. Co. Ltd. 25
Hurtubise Tp. 25

Iron formation 14,25
Iron oxide staining. 25

Kelly, V.N. 2
Kelly-K Mines Ltd. 32
Kenning Tp. 25

Lacustrine clay 20
Lake Barlow-Ojibway, glacial. 21
Lapilli 11
Lapillistone 11
Lineaments:
  Aeromagnetic 21
Lithologic Units, Table of 6

PAGE

Mafic flows-micaceous metasediments, contact 6,7
Magiskan Lake 3,7,11,20,21, 22,24,27,28,31
Magnetite. 15,27,30,31
Iron formation 26,27
Metamorphism, low grade 3
Metavolcanic-micaceous metasediment, contact 34
Metavolcanics. 3
Mikwam River 31

Newman Tp.. 26,27
Noranda Expl. Ltd. 25,30,31

Ojibway-Barlow, Glacial Lake 21
Outwash deposit 21

Peridotite:
Texture 19
Phenocrysts:
Plagioclase 10
Potassic feldspar 20
Pillowed-unpillowed rock, contacts. 7
Pillows 7,8,9
Pillow shapes 22,24
Porphyritic granodiorite 20
Pyrite 25,27,31,32,33,34
Pyroclastic rocks:
Bedding thickness 11
Felsic 26
Pyrrhotite 25,27,30,31,32,33,34

Quartz. 34

St.-Laurent Tp. 25
Shears 24

PAGE

Silt 21
Singer Tp. 25
South Floodwood Lake 14,15,21,29
South Floodwood River 4,9,14,22,24
Springer Lake 24
Structural interpretation. 22
Sulphide minerals 25,27
See also: Chalcopyrite; Pyrite; Pyrrhotite.
Synclines 24

Texas Gulf Sulphur Co. 2,15
Texture:
Diabase 20
Granodiorite. 20
Porphyritic granodiorite 20
Thickness:
Beds, chemical sedimentary rocks. . . .18
Mafic flows 7
Metasediments 15
Sandstone schist 14
Ultramafic sills and dikes 18
Tholeiitic suite 10
Tomlinson Lake 33
Tomlinson Tp. 25,27
Tourmaline 18
Tuff, crystal 11
Turbidite sedimentation 14,15

Unpillowed-pillowed rock, contacts 7

Varved clay 20
Volcanic centres 9,22,24,34

Wasicho Lake 21,30
West Porphyry Lake. 25,28,30,33
Wisconsinan glaciation 21

MAPS
NOT
FILMED

CARTES
OMISES